



● GB 2003 / 0 0 1 4 2 7

01 APRIL 2003

**PRIORITY
DOCUMENT**

REC'D 23 APR 2003

WIPO	PCT
------	-----

I, the undersigned, being an officer duly authorised in accordance with Section 74(1) and (4) of the Deregulation & Contracting Out Act 1994, to sign and issue certificates on behalf of the Comptroller-General, hereby certify that annexed hereto is a true copy of the documents as originally filed in connection with the patent application identified therein.

In accordance with the Patents (Companies Re-registration) Rules 1982, if a company named in this certificate and any accompanying documents has re-registered under the Companies Act 1980 with the same name as that with which it was registered immediately before re-registration save for the substitution as, or inclusion as, the last part of the name of the words "public limited company" or their equivalents in Welsh, references to the name of the company in this certificate and any accompanying documents shall be treated as references to the name with which it is so re-registered.

In accordance with the rules, the words "public limited company" may be replaced by p.l.c., plc, P.L.C. or PLC.

Re-registration under the Companies Act does not constitute a new legal entity but merely subjects the company to certain additional company law rules.

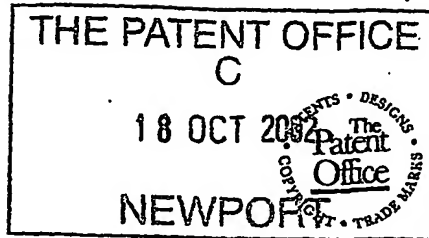
Signed

M. C.

Dated 17 December 2002

Patents Form 1/77

Patents Act 1977



0224250.1

1/77

Request for grant of a patent
Grant

The Patent Office
Concept House
PO1/7700 0. Cardiff Road
Newport
Gwent NP10 8QQ

1. Your reference 2343-P101-GB

2. Patent application number 0224250.1

3. Full name, address and postcode of the or of each applicant (*underline all surnames*)
WOOTON, Shane Richard
No. 3 The Heronry
Lakeside View
Penistone
Barnsley S36 7EX
United Kingdom

Patents ADP number (*if you know it*)

If the applicant is a corporate body, give the country/state of its incorporation

N/A

4. Title of the invention Dispensing Material Produced by a Chemical Reaction

5. Name of your agent ATKINSON BURRINGTON

"Address for service" in the United Kingdom to which all correspondence should be sent

25-29 President Buildings
President Way
Sheffield S4 7UR
GB

Telephone No:

0114 275 2400

Patents ADP number

7807043001

6.	If you are declaring priority from one or more earlier patent applications, give the country and the date of filing of the or of each of these earlier applications and (<i>if you know it</i>) the or each application number	Country	Priority application number (<i>if you know it</i>)	Date of filing (<i>day/month/year</i>)
		N/A	N/A	N/A

7.	If this application is divided or otherwise derived from an earlier UK application, give the number and the filing date of the earlier application	Number of earlier application	Date of filing (<i>day/month/year</i>)
		N/A	N/A

8. Is a statement of inventorship and of right to grant of a patent required in support of this request?

No

Patents Form 1/77

9. Enter the number of sheets for any of the following items you are filing with this form. Do not count copies of the same document

Continuation sheets of this form

Description

15

Claim(s)

04

Abstract

00

Drawings

06

16. RM

10. If you are also filing any of the following, state how many against each item.

Priority documents

N/A

Translations of priority documents

N/A

Statement of inventorship and right to grant of a patent (Patents Form 7/77)

N/A

Request for preliminary examination and search (Patents Form 9/77)

None

Request for substantive examination (Patents Form 10/77)

None

Any other documents (Please specify)

11.

I/We request the grant of a patent on the basis of this application.

Signature



Date Thursday, 17 October 2002

12. Name and daytime telephone number of person to contact in the United Kingdom

RALPH ATKINSON CPA
0114 275 2400

Dispensing Material Produced by a Chemical Reaction

Background of the Invention

1. Field of the Invention

5 The present invention relates to apparatus for dispensing material produced by a chemical reaction between a first chemical re-agent and a second chemical re-agent. The dispensed material may be foam-like or elastameric. Preferably, the material is in a fluid state allowing it to be cast and then cured into a substantially solid construction.

10

2. Description of the Related Art

 Foam-like material such as polyurethane is produced in situ so that it expands and sets into required shapes. A first chemical re-agent may be a diol and a second chemical re-agent may be a diisocyanate. In addition,
15 small amounts of water are added to the reaction mixture during the polymerisation process to produce carbon dioxide gas that acts as the foaming agent.

 High pressure systems are known in which the chemical re-agents are brought into contact under high velocity having been released from
20 respective high pressure nozzles. High pressure systems of this type produce good quality polyurethane foam and require minimal maintenance. However, a problem with these systems is that output rates tend to be relatively high and attempts to scale down output production by reducing the size of the apparatus, and thereby reducing the volume of material
25 released from the respective nozzles, have introduced further engineering difficulties.

Low pressure systems are known that use mechanical mixing operations and are thereby capable of operating at lower output rates/volumes. However, low pressure systems introduce further problems in that the quality of the mix tends to be lower than that produced by high pressure systems and organic solvents are required on a regular basis to effect the cleaning of a mixing chamber. In both of these known systems the rate of foam production is controlled by controlling the flow of the individual re-agents.

Brief Summary of the Invention

According to an aspect of the present invention, there is provided an apparatus for dispensing material produced by a chemical reaction between a first chemical re-agent and a second chemical re-agent, wherein said material is produced intermittently at a first rate of production; said produced material is held temporarily at a dispensing device; and said temporarily held material is dispensed from said dispensing device at a second rate of dispensing.

By providing for the temporary holding of reacting material, it is possible for the material to be produced at a first high rate thereby making use of preferred high pressure techniques. Therefore the foam-like material may be dispensed at much lower rates, consistent with low pressure systems while taking advantage of the improved mixing qualities of the high pressure system and without requiring environmentally unfriendly organic solvents for cleaning purposes.

Brief Description of the Several Views of the Drawings

Figure 1 shows an example of A chemical reaction for producing a foam-like polyurethane;

5 *Figure 2* shows a facility for the production of air filters;

Figure 3 illustrates a device for dispensing material;

Figure 4 illustrates the operation of the device shown in *Figure 3*, including a dispensing head;

Figure 5 details the dispensing head identified in *Figure 4*;

10 *Figure 6* illustrates operations performed by a computer control system.

Written Description of the Best Mode for Carrying Out the Invention

Figure 1

15 An example of a material that is produced by a chemical reaction between a first chemical component and a second chemical component is polyurethane. A urethane 101 is produced when an alcohol 102 reacts with an isocyanate 103. Typically, polyurethanes 104 are made by reacting a diol 105 with a diisocyanate 106. Preferably, large diisocyanate molecules
20 are deployed as these are less hazardous.

Figure 2

Polyurethanes, and similar materials, have many applications in situations where flexible light-weight materials are required. For the
25 purpose of providing an illustration only, a facility is shown in *Figure 2* for the production of air filters. A plurality of stations 201, 202 etc are provided

in a substantially circular configuration. A robotically controlled arm is positioned at a first station so as to apply an edge of fluid unset polyurethane onto which an air filter membrane is applied. The air filter membrane is secured in place as the applied polyurethane foam sets after a curing period. The number of stations provided in the assembly is therefore configured such that the application of polyurethane may be substantially continual, with an air filter being removed prior to a new filter being constructed at the station in question.

The amount of polyurethane required in order to construct an air filter using the facility shown in *Figure 2* is relatively low and a relatively low production rate is required as the polyurethane is being laid into a mould prior to the filter membrane being applied. Consequently, there are difficulties in terms of using high pressure systems therefore there has been a tendency towards using low pressure systems, with the inherent disadvantages previously discussed. The present preferred embodiment allows a relatively low flow of polyurethane to be produced as required by the production facility shown in *Figure 2* while at the same time allowing materials to be reacted at high pressure thereby improving quality and removing the need for cleaning procedures using organic solvents.

Figure 3

A device for dispensing material in accordance with the present preferred embodiment is illustrated in *Figure 3*. In this example, the material is polyurethane being dispensed for the production of air filters as described with respect to *Figure 2*, purely as an illustrative example.

A first chemical component is stored in a first storage container 301 with the second being stored in a second storage container 302. Pumping devices 303 provide for circulation of the reactants and their application to nozzles at high pressure. Reacted polyurethane foam is dispensed from a head 304 and the overall operation of the device is controlled by a computer system 305.

Figure 4

Operation of the dispensing device illustrated in *Figure 3* will be described with reference to the schematic representation shown in *Figure 4*. A pump 401 pumps the first chemical re-agent from the first storage container 301. A valve 402 may be placed in a first position such that the re-agent is returned to the storage container 301. Similarly, a second pump 403 pumps the second chemical re-agent from the second container 302. A valve 404 when placed in its first condition returns the second re-agent to the second container 302. When polyurethane foam is required, either in response to manual operation or in response to program controlled robotics, both valves 402 and 404 are placed in their alternative condition thereby supplying the first chemical re-agent and the second chemical re-agent to the mixing head 304.

In conventional mixing heads polyurethane foam is expelled in response to the re-agents being supplied to the head. Thus, the rate of polyurethane output is directly controlled in response to the input rate of the component re-agents in known systems. In the present preferred embodiment, the head 304 consists of a reaction chamber 405 and an output dispensing chamber 406. The dispensable material is generated

within the input reaction chamber 405 under a procedure that is substantially similar to conventional high pressure/high velocity techniques. However, this relatively high volume production is not sent directly to an output port 407. As the material is created, it is supplied to an output
5 dispensing chamber 406 and held in this output chamber. Having filled the output dispensing chamber 406 to a required amount, material is then dispensed from the output dispensing chamber 406 via the output port 407. In this way, the rate at which material is released from the output dispensing chamber 406 is independent of the rate at which the
10 dispensable material is generated within the input reaction chamber 405.

Figure 5

A cross section of head 304 is illustrated in *Figure 5*. This consists of a relatively small input reaction chamber 405 having a volume of typically
15 one cubic centimetre. This is connected to the output dispensing chamber 406 having a volume of typically one hundred cubic centimetres or typically in a range from five cubic centimetres to two hundred and fifty cubic centimetres. The first chemical re-agent is supplied to a first reaction nozzle 501 and the second chemical re-agent is supplied to a second reaction
20 nozzle 502. When valves 402 and 404 are placed in their alternative conditions, the first re-agent released from nozzle 501 is brought into violent contact with the second re-agent released from nozzle 502 at high impact velocity. This results in dispensable material (polyurethane in this illustrative example) being generated at a relatively high rate as it is
25 supplied into the output dispensing chamber 406.

The output dispensing chamber 406 includes an output orifice 503 and an output pipe 504 extending from said output orifice 503. Prior to the generation of polyurethane an output control rod 505 descends in the direction of arrow 506 in order to block the output orifice 503. The output control rod 505 is surrounded by a dispensing piston 507. Prior to the generation of polyurethane within the input reaction chamber, the dispensing piston 507 ascends in the direction of arrow 508 in order to create vacuum conditions within the output dispensing chamber 405. Thus, as the foam-like material is produced by the chemical reaction within the input reaction chamber 406, said foam is received within the output dispensing chamber 406 where it is allowed to continue to expand and react and possibly expand.

In the majority of preferred applications, the input reaction will tend to occur relatively quickly resulting in the output dispensing chamber being filled relatively quickly. The material held temporarily within the dispensing device will then be dispensed at a relatively slower rate thereby allowing the head to dispense polyurethane foam in environments where a relatively slow flow-rate is required. However, it is appreciated that all of the material contained within the output dispensing chamber 406 must be removed while the material remains in a fluid state. Thus, in this way, high quality material may be produced, due to the high pressure mixing while being dispensed at a relatively lower rate thereby increasing the number of applications where high pressure mixed material may be deployed.

The dispensing of material is initiated by the movement of output control rod 505 in an upwards direction, that is in the opposite direction to arrow 506, thereby opening the output orifice 503. Thereafter, dispensing

piston 507 is forced to move in a downward direction, that is in the opposite direction to arrow 508, thereby forcing the produced material to be dispensed through the output pipe 504 via the output orifice 503. The output control rod 505 is raised such that its bottom surface 509 becomes level with line 510. This is because after a number of operations there will tend to be a build-up of solid polyurethane at the bottom of the output dispensing chamber 406.

The dispensing piston 507 dispenses measured quantities of output material and sensors are provided to ensure that the computer control system 305 receives information specifying the exact position of the dispensing piston 507. Thus, it is possible for the computer system 505 to calculate whether sufficient material is contained within the output dispensing chamber 406 for a further unit output to be generated. In this way, unit outputs continue to be generated until the output chamber is determined to be empty whereupon the entire cycle may repeat and further material may be generated within the input reaction chamber 406.

As the overall cycle repeats, there will be a tendency for more and more reacted polyurethane to accumulate at the bottom of the output dispensing chamber 406. Consequently, the computer control system 305 only permits a pre-determined number of cycles to be performed before performing a expunging operation. Under normal operation the piston 507 is pushed downwards to a pre-determined extent before it is determined that the output dispensing chamber is considered to be empty and the cycle is repeated. However, in an expunging operation, the dispensing piston is lowered to a greater extent effectively bringing it flush with the inside surface of the bottom of the output dispensing chamber 406. Under these

conditions the excess build up of reacted material is expressed through orifices 511 extending through the output dispensing chamber. Initially, orifices 511 are blocked with reacted material, whereafter, expunging operations will result in reacted material being expressed through the orifices while leaving the orifices in a blocked condition such that the cycle may repeat.

Figure 6

Operations performed by the computer control system (or similar such as a programmed logic controller or a micro-controller etc) 305 in order control the dispensing of the material are illustrated in *Figure 6*. Step 601 represents a set-up procedure where it is possible to adjust the relative volumes of the two reacting components. Thus, in many applications an even mix of diol and diisocyanate is required but for specialist applications an alternative mix may be preferred. Experience has shown that when alternative mixes are required even greater problems are encountered in terms of producing low volumes using high pressure techniques. The set-up procedures also specify the dispensed volume in terms of the total amount of material required for a specified time. The set-up procedures also identify the dispense rate. In many applications, material is not being dispensed continuously. The dispense rate value therefore represents the rate at which material is released when it is actually being dispensed. The dispensed volume refers to the total volume required over unit time and therefore takes account of periods when material is not being released.

It should be appreciated that many other set up parameters may be specified and that the procedures identified in *Figure 6* would form part of a

much larger set of procedures for controlling the entire operation. Operations of the dispensing devices may also be co-ordinated with other computer controlled robotics.

5 The system includes a device for activating the apparatus to the effect that material is required. This may consist of a manual button or it may consist of an interface from a robotic system. Activation of this button or interface provides an instruction to the effect that the foam-like material is required at the pre-specified dispense rate. Thus, a question is asked at step 602 as to whether the dispenser has been activated and when
10 answered in the negative a wait state is entered at step 603. Thus, this wait loop continues until the question asked at step 602 is answered in the affirmative to the effect that the dispenser has been activated.

In response to the question asked at step 602 being answered in the affirmative, a question is asked at step 605 as to whether the output
15 dispensing chamber is ready. If material has been generated and is presently held within the output dispensing chamber the question asked at step 604 will be answered in the affirmative. Alternatively, if the output dispensing chamber is empty the question asked at step 604 will be answered in the negative. In response to the question asked at step 604
20 being answered in the negative, the output in the form of the output orifice 503 is closed by the activation of the output control rod in the direction of arrow 506.

At step 606 the output dispensing chamber is evacuated by the movement of dispensing piston 507 in the direction of arrow 508.

25 At step 607 material is generated by valves 402 and 404 being placed in their alternative condition resulting in the re-agents being

expressed from nozzles 501 and 502 at high velocity. Consequently, material is generated within the input reaction chamber 405 for a pre-determined period under program control so as to provide an appropriate volume of material to the output dispensing chamber 406.

5 Having supplied the required amount of material to the output dispensing chamber 406 the output orifice 503 is opened at step 608 by the movement of the output control rod in an upwards direction.

 At step 609 a unit of material is dispensed through the output pipe 504 whereafter a question is then asked at step 610 as to whether the operation is complete. When answered in the negative control is returned to
10 step 602 which, in a first iteration, would tend to result in a question at step 602 being answered in the affirmative to the effect that the dispenser is still activated. On the previous cycle, the output dispensing chamber 406 was filled therefore the question asked at step 604, as to whether the output
15 dispenser is ready, would tend to be answered in the affirmative. Thus, a further unit of material will be dispensed at step 609 and further iterations around the loop would be effected.

 As further operations take place, the output dispensing chamber will eventually be emptied resulting in the question asked at step 604 being
20 answered in the negative. Consequently more material is generated which is then subsequently expelled from the output dispensing chamber. Thus, it can be appreciated that the material is generated under ideal conditions that are not affected by the rate at which the material is ultimately expelled. Eventually, the operation will be completed resulting in the question asked
25 at step 610 being answered in the affirmative.

Conclusions

The preferred embodiment allows the rate at which material is mixed (to initiate chemical reaction) to be separated from the rate at which the output material is dispensed. Experimentation suggests that the material may be held within the output dispensing chamber 406 for a maximum period of twenty seconds. The embodiment allows material to be dispensed at low rates (for example at three grams per second or lower) using equipment that does not need to be cleaned but would normally produce output material at a rate of fifty grams per second. Low dispensing rates usually require low pressure systems to be used which use organic solvents in a cleaning cycle usually taking a minimum of forty five seconds representing system downtime. Thus, the preferred embodiment removes the need for hazardous cleansing materials to be used while at the same time reducing downtimes. This benefits industries such as the previously described manufacture of engine filters where a typical facility may produce of the order of one thousand filters per hour.

The rate of dispensing in the preferred embodiment is fully detached from the rate of mixing therefore the output rate is very flexible. Thus, a single machine may offer many different output flow-rates by simple modifications to the dimensions of the output dispensing chamber.

It is possible to fit two (or more) pouring chambers thereby allowing two types of material to be dispensed from the same head. Under these conditions, it is possible to recharge chambers alternately from different chamber types such that the same head may dispense soft or hard material on alternate cycles.

A further advantage of the preferred embodiment is that the pressure at which the material is dispensed from the output orifice 503 is not related to the pressure encountered within the input reaction chamber 405. Thus, under some circumstances the pressure at which the material is released through orifice 503 may be greater than the pressure encountered within the input reaction chamber 405 during foam formation. The pressure encountered by the output dispensing chamber 406 is not felt by pumps 401 and 403 when valves 402 and 404 are in their closed condition while material is being dispensed. When operating at high pressures, an additional plate would be required over the bottom surface of the output dispensing chamber 406 having holes that may be aligned with the holes 511 shown in *Figure 5*. Rotation of this plate would place the holes either in phase or out of phase; the out of phase condition being used during the high pressure dispensing with the in phase condition being used during the expunging of collected material.

In an alternative embodiment, colour is injected down the centre of the input reaction chamber 405 so as to provide efficient mixing of colour pigments prior to the material being received within the output dispensing chamber 406.

During operation, the volume of the output dispensing chamber is effectively variable given that the extent to which dispensing piston 507 is raised may be adjusted.

The provision of the output control rod 505 ensures that there is no leakage when material is not required. In the event of power failure, both the input reaction chamber and the output dispensing chamber are closed and the output control rod is raised so as to open the dispensing orifice

503. Consequently, it is not possible for material to set and cure within either the input reaction chamber 405 or the output dispensing chamber 406. In this way, it is possible for production to restart without requiring additional cleaning operations to be performed.

5 The ability to adjust the rates at which material is dispensed provides an opportunity for the dispensed rate to be controlled and adjusted within a particular dispensing operation. Thus, for example, when producing a foam bead it would be possible for part of the bead to have a larger area by increasing the rate at which the material is released as an alternative to
10 reducing the speed of a robotic movement. This greater flexibility may increase production speeds and may reduce mechanical constraints placed upon robotic operations.

 In a standard high pressure system, a mixing head is required to open and close at each pouring of material. A start of mixing and an end of
15 mixing create situations of pour impingement due to the deflecting effect created by the blind end section of the groove mixing piston. Thus, situations often occur in which the start of a flow and the end of a flow are sub-standard and this may result in products being rejected. In the present preferred embodiment, material created at the start of material production
20 and at the end of material production are mixed together within the output dispensing chamber such that material released from the output dispensing chamber 406 is substantially homogenous.

 Standard high pressure mixing heads perform a finite number of cycles before periodic maintenance is required. Typically, a mixing head will
25 perform five thousand to five hundred thousand cycles depending upon the type of materials being processed. In some situations relatively short bursts

of activity are required to produce relatively small volumes and this in turn will lead to a shorter active life. The present embodiment allows a number of activations within the input reaction chamber to be reduced given that more material may be produced on each activation and then held temporarily within the output dispensing chamber.

In a preferred embodiment, the tolerance between the dispensing piston 507 and the inside wall of the output dispensing chamber 406 will be between ten microns and fifteen microns. Preferably, the diameter of the dispensing piston 507 will be approximately fifty millimetres requiring a dispensing force of in the region of four hundred kilograms. Preferably, the output control rod 505 will have a diameter of ten millimetres and the total area of contact between all moving surfaces will be sufficient to provide effective sealing but will not be so great as to create sticking problems.

Claims

1. Apparatus for dispensing material produced by a chemical reaction between a first chemical re-agent and a second chemical re-agent,
5 wherein
said material is produced intermittently at a first rate of production;
said produced material is held temporarily at a dispensing device;
and
said temporarily held material is dispensed from said dispensing
10 device at a second rate of dispensing.
2. Apparatus according to claim 1, wherein said dispensed material is polyurethane produced by reacting a diol as the first chemical re-agent with a diisocyanate as the second chemical re-agent.
15
3. Apparatus according to claim 1, wherein said first rate of production is relatively high.
4. Apparatus according to claim 1, wherein said material is
20 produced by ejecting said first chemical re-agent from a first nozzle under high pressure and by ejecting said second chemical re-agent out of a second nozzle under high pressure.
5. Apparatus according to claim 1, wherein said second rate is
25 relatively low.

6. Apparatus according to claim 1, including a dispensing chamber for temporarily holding said material.

5 7. Apparatus according to claim 6, wherein said dispensing chamber includes an orifice and a piston for dispensing said material from said orifice.

8. Apparatus according to claim 7, including closing means for
10 closing said orifice during material production.

9. Apparatus according to claim 1, including expunging means for removing built-up reacted material.

15 10. Apparatus according to claim 1, including input interface means for receiving command instructions from a programmable control system.

11. A method of dispensing material produced by a chemical
20 reaction between a first chemical re-agent and a second chemical re-agent, comprising the steps of

producing material intermittently at a first rate of production;

holding said produced material temporarily;

25 dispensing said temporarily held material at a second rate of dispensing.

12. A method according to claim 11, wherein said dispensed material is polyurethane produced by reacting a diol as the first chemical re-agent with a diisocyanate as a second chemical re-agent.

5

13. A method according to claim 11, wherein said first rate of production is relatively high.

10 14. A method according to claim 11, wherein said material is produced by ejecting said first chemical re-agent from a first nozzle under high pressure and by ejecting said second chemical re-agent out of a second nozzle under high pressure.

15 15. A method according to claim 11, wherein said second rate is relatively low.

16. A method according to claim 11, including a dispensing chamber for temporarily holding said material.

20 17. A method according to claim 16, wherein said dispensing chamber includes an orifice and a piston for dispensing said material from said orifice.

25 18. A method according to claim 17, including closing means for closing said orifice during material production.

19. A method according to claim 11, including expunging means for removing built-up reacted material.

5 20. A method according to claim 11, where in operations are controlled in response to instructions received from a programmable control system.

10 21. Apparatus for dispensing material substantially as herein described with reference to *Figures 3, 4 and 5*.

 22. A method of dispensing materials substantially as herein described with reference to *Figures 4, 5 and 6*.

1/6

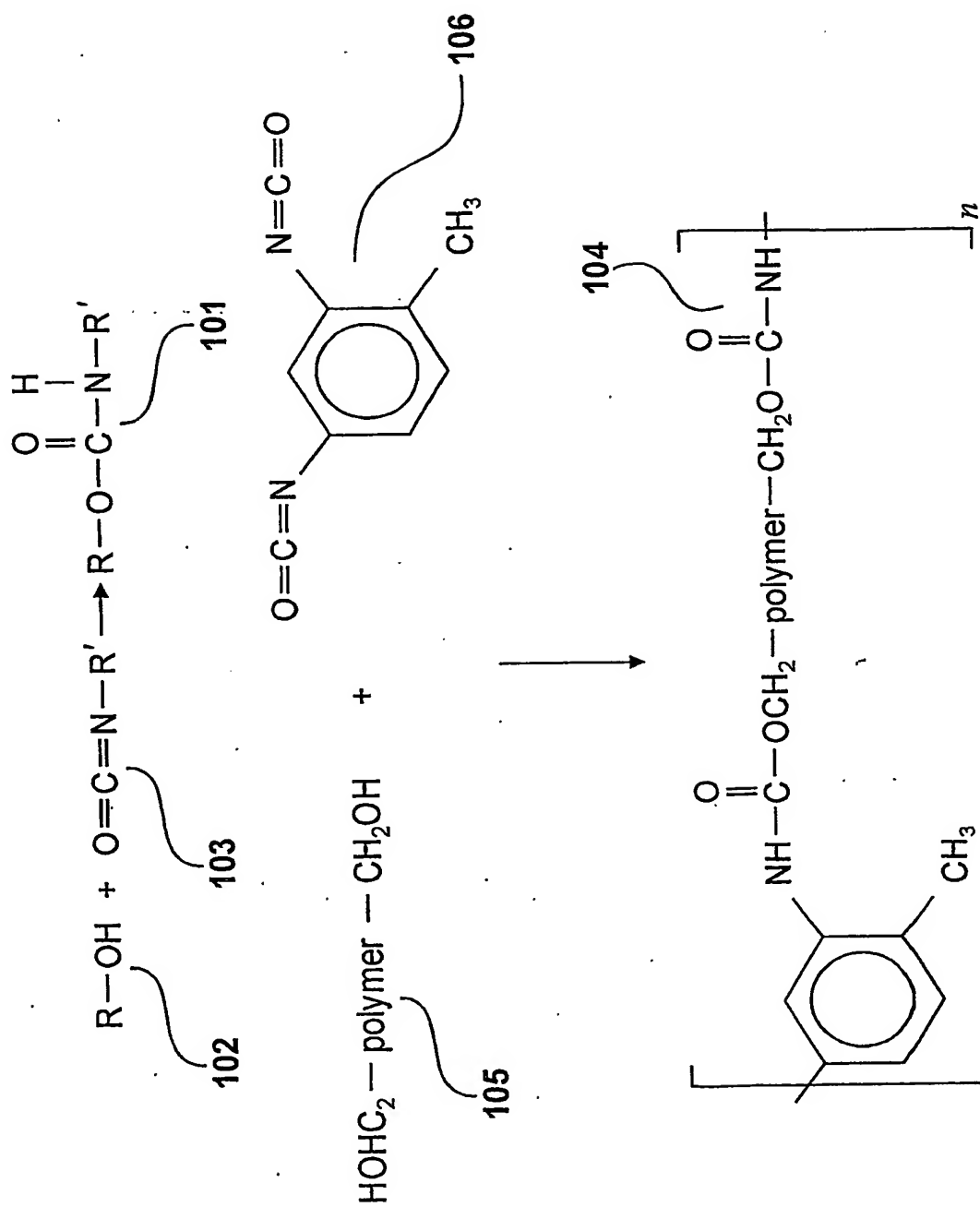
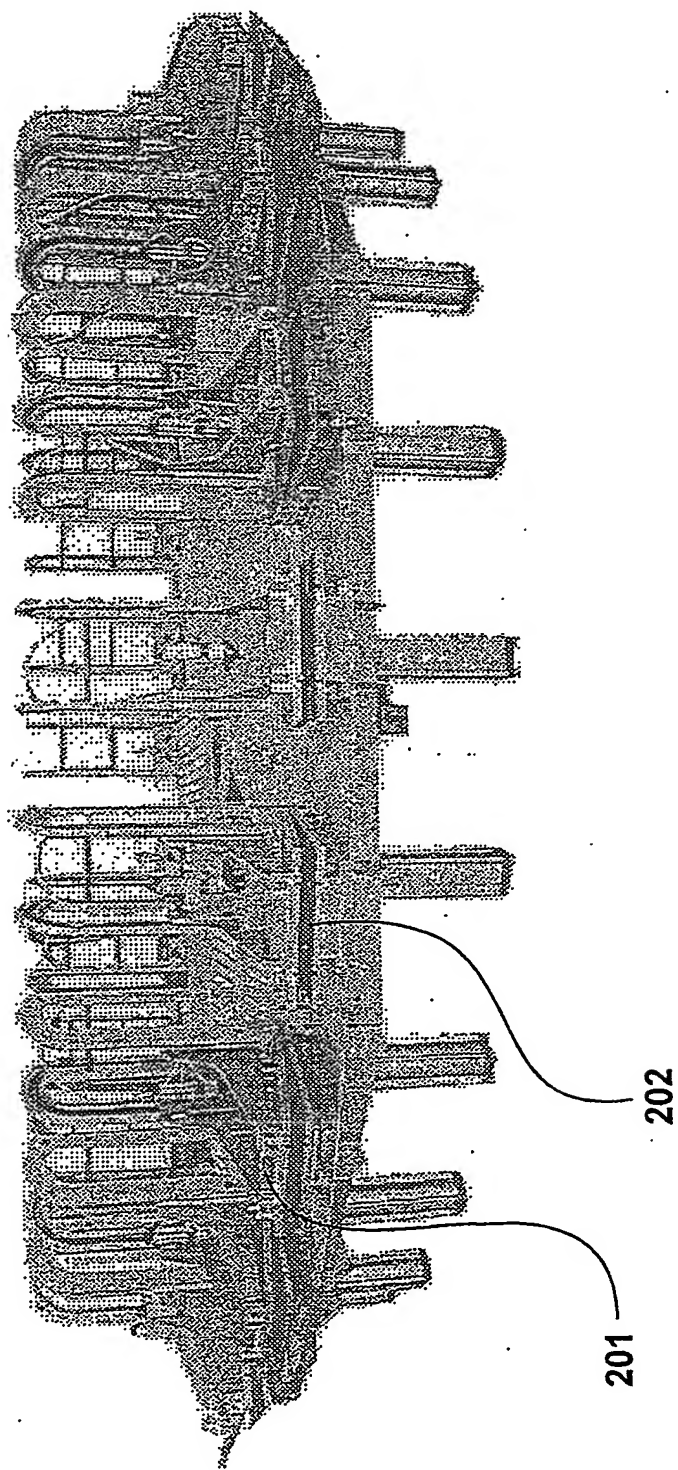
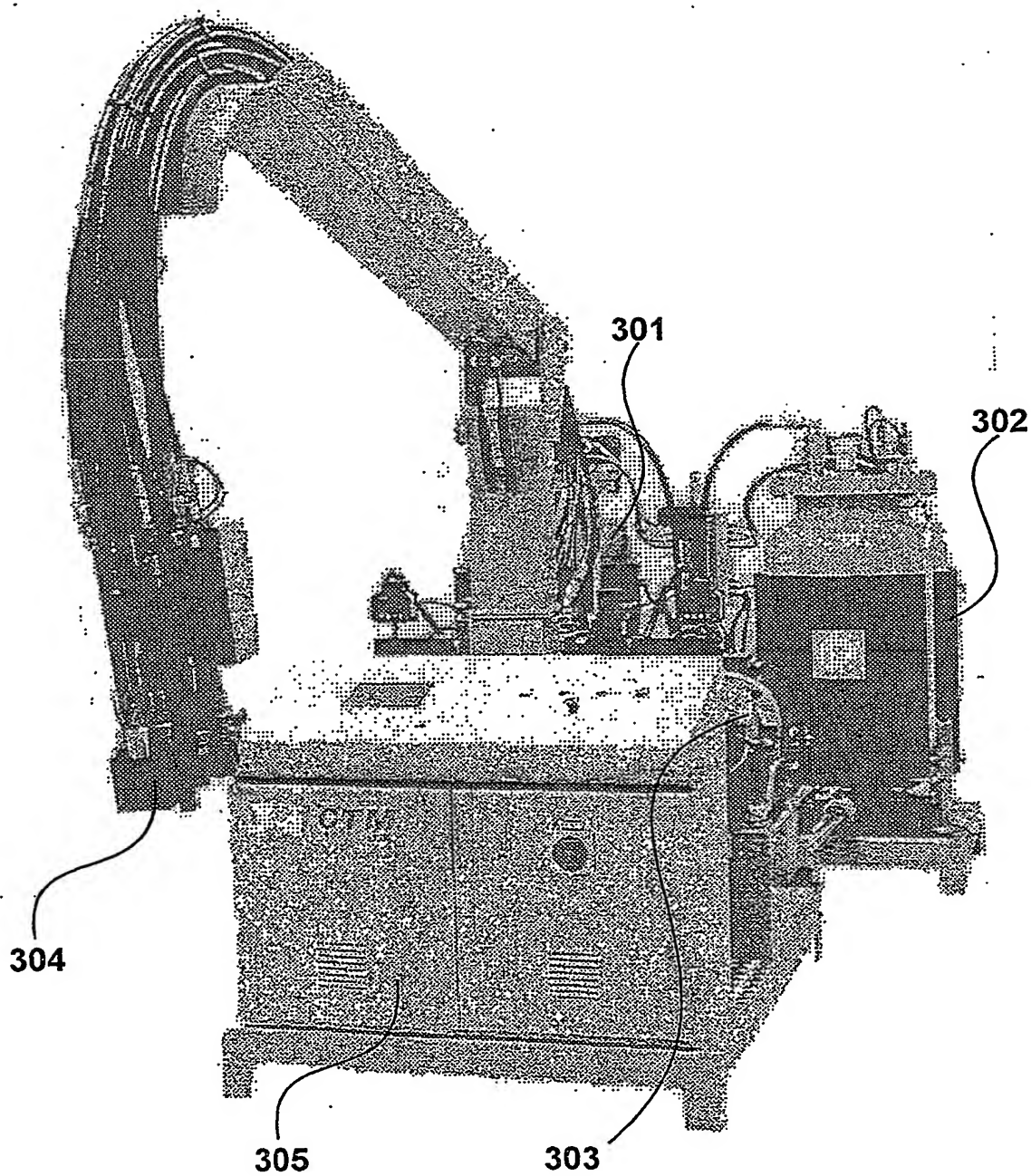


Figure 1

2/6

*Figure 2*

3/6

*Figure 3*

4/6

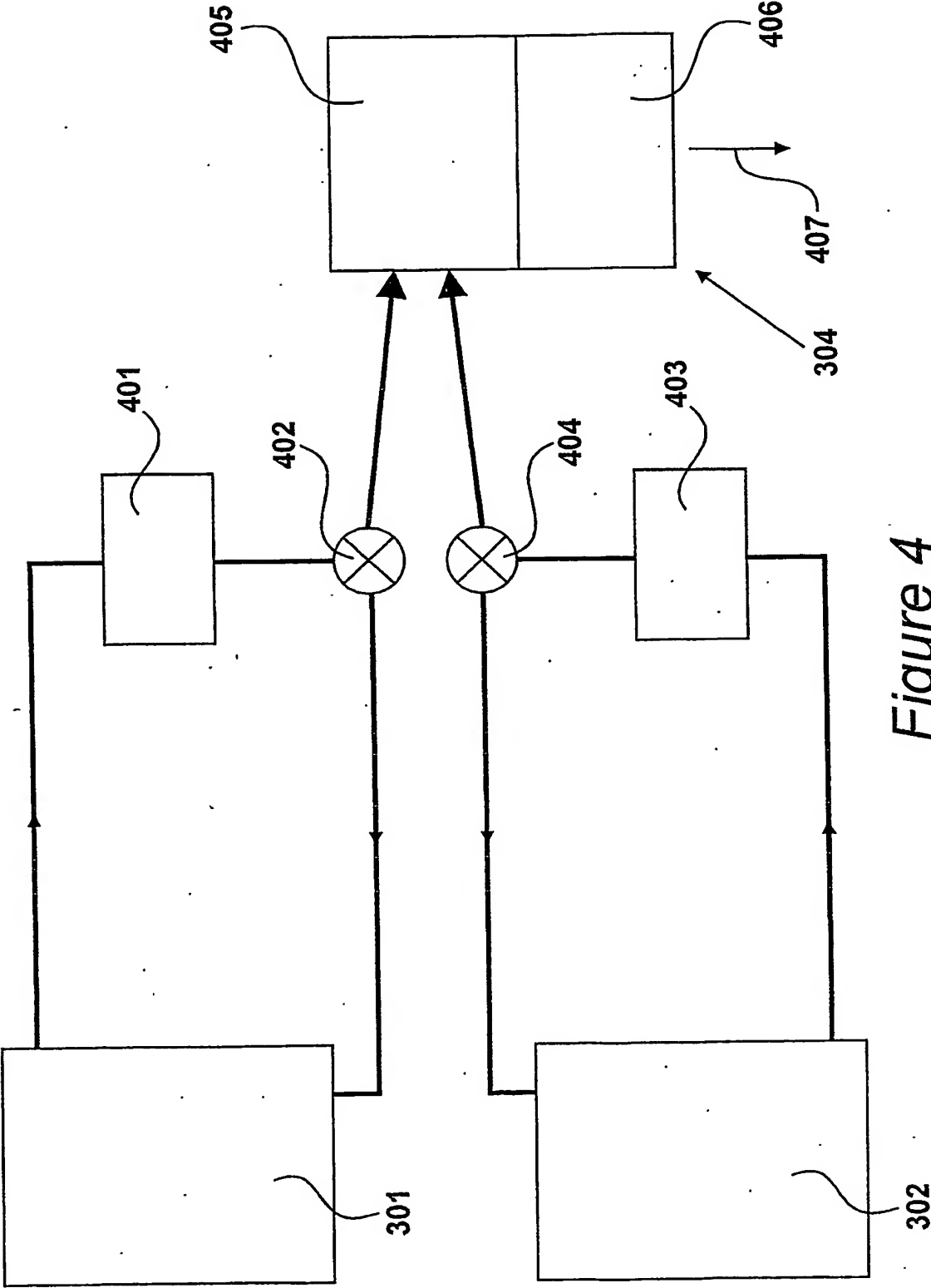
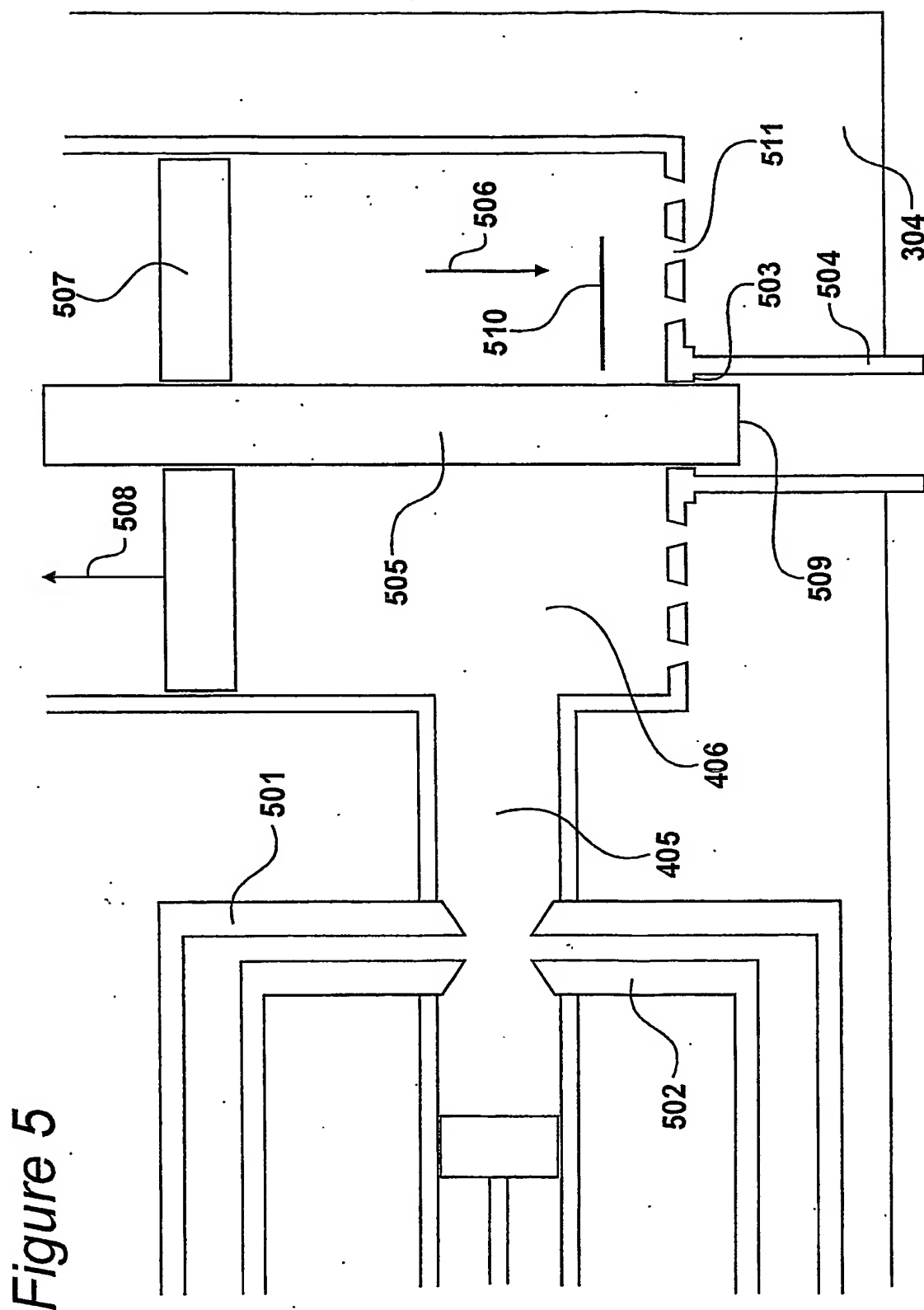


Figure 4



6/6

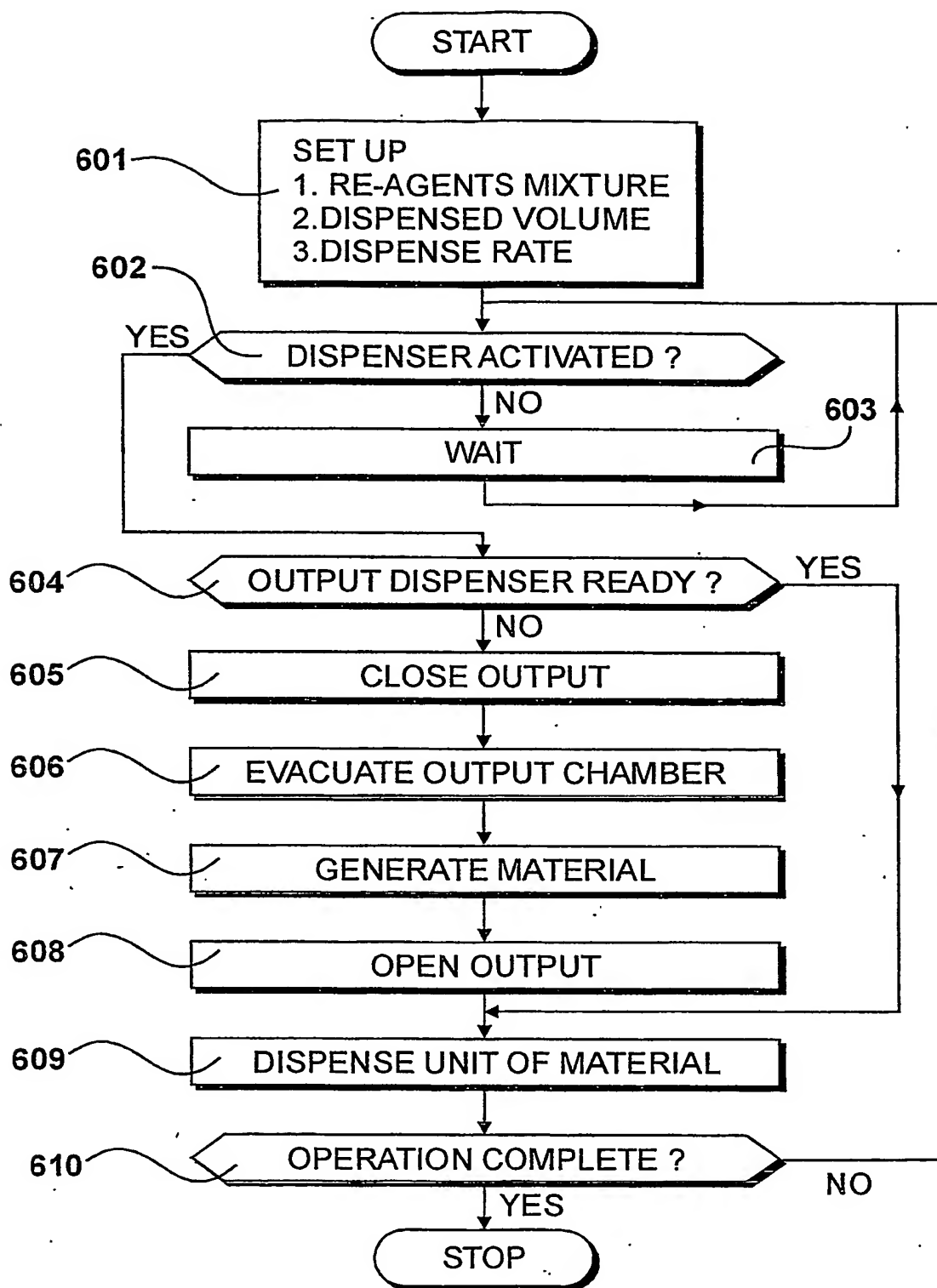


Figure 6